SCOPE OF CLAIMS

1. A captured image data processing method characterized by:

a step of subtracting, from a pixel value of each pixel which constitutes second image data acquired by way of an imaging process causing a first light source to emit light, a pixel value of a corresponding pixel of first image data acquired by way of an imaging process causing the first light source not to emit light, and obtaining difference image data corresponding to an image captured in an irradiation environment of only the first light source;

a difference image data pixel value adjustment processing step of performing a pixel value adjustment process with respect to the difference image data; and

a final pixel value adjustment image generation step of applying image data of adjusted pixel values generated in the difference image data pixel value adjustment processing step, and generating a final pixel value adjustment image.

2. The captured image data processing method according to claim 1, characterized by further including :

a first image data pixel value adjustment processing step of performing pixel value adjustment process with respect to the first image data; wherein

the final pixel value adjustment image generation step is a step of performing a pixel value addition process for the corresponding pixels of two image data of adjusted pixel values acquired by the difference image data pixel value adjustment processing step and the first image data pixel value adjustment processing step, and generating final pixel value adjustment image data.

3. The captured image data processing method according to claim 2,

characterized in that the pixel value adjustment process is a white balance adjustment process;

the difference image data pixel value adjustment processing step is a white balance adjustment process according to a parameter set based on an light component of the first light source, and the first image data pixel value adjustment processing step is a white balance adjustment process according to a parameter set based on an ambient light component which does not contain the first light source.

4. The captured image data processing method according to claim 3, characterized in that the parameter is a parameter represented by a 3×3 matrix, the matrix applied for conversion of color components which constitute a color of each pixel.

5. The captured image data processing method according to claim 4, characterized in that the 3×3 matrix is a matrix set as 0 with exception to diagonal components.

6. The captured image data processing method according to claim 1, characterized by further including a pixel value addition step of adding a pixel value of each pixel of the image data of adjusted pixel values generated in the difference image data pixel value adjustment processing step to a pixel value of a corresponding pixel of the first image data; wherein

the final pixel value adjustment image generation step is a step of performing the pixel value adjustment with respect to the image data generated in the pixel value addition step, and generating the final pixel value adjustment image data.

7. The captured image data processing method according to claim 6, characterized in that the pixel value adjustment process is a white

balance adjustment process; and

the difference image data pixel value adjustment processing step is a white balance adjustment process according to a parameter set based on ambient light component which does not contain the first light source.

8. The captured image data processing method according to claim 1, characterized by further including:

a motion detecting step of detecting a moving portion where a subject moves according to the difference data of a plurality of image data; and

a moving portion pixel value adjustment step of performing pixel value adjustment process with respect to the moving portion.

9. The captured image data processing method according to claim 8, characterized in that the moving portion pixel value adjustment step has:

a step of calculating a light intensity scalar ratio of two light sources when the first light source is caused or not caused to emit light, as data corresponding to a pixel of a motionless portion adjacent to a moving portion;

a step of using a radial basis function (RBF) so as to calculate the light intensity scalar ratio corresponding to each pixel of the moving portion;

a first pixel value calculation step of calculating the pixel value, as the first pixel value, of each pixel of the moving portion in an image which is equivalent to the image captured in an irradiation environment of the first light source only, based on the light intensity scalar ratio corresponding to each pixel of the moving portion;

a second pixel value calculation step of calculating the pixel value, as the second pixel value, of each pixel of the moving portion in an image which is equivalent to the image captured in an ambient light irradiation environment where the first light source is not included, based on the

light intensity scalar ratio corresponding to each pixel of the moving portion;

a first pixel value adjustment processing step of performing the pixel value adjustment process, based on the first pixel value calculated in the first pixel value calculation step;

a second pixel value adjustment processing step of performing the pixel value adjustment process, based on the second pixel value calculated in the second pixel value calculation step; and

a pixel value addition step of adding two adjustment pixel values generated in the first pixel value adjustment processing step and the second pixel value adjustment processing step.

10. The captured image data processing method according to claim 9, characterized in that the pixel value adjustment process is a white balance adjustment process;

the first pixel value adjustment processing step is a white balance adjustment process according to a parameter set based on light component of the first light source; and

the second pixel value adjustment processing step is a white balance adjustment process according to a parameter set based on an ambient light component which does not contain the first light source.

11. The captured image data processing method according to claim 8, characterized in that the moving portion pixel value adjustment step further has:

a step of calculating a color component ratio (α_r, α_g, α_b) of a pixel value of an inner peripheral pixel of the moving portion to an average pixel value of outer peripheral pixels of the moving portion adjacent to the inner peripheral pixel of the moving portion;

a step of constructing the radial basis function (RBF) based on the color component ratio corresponding to each pixel by considering all the

inner peripheral pixels in the moving portion as sample points; and

a step of calculating the color component ratio corresponding to each pixel of the moving portion, based on the radial basis function (RBF), and multiplying the color component ratio with an image to be compensated and obtaining a compensation pixel value.

12. The captured image data processing method according to claim 1, characterized by further including:

a motion detecting step of detecting a moving portion where a subject moves according to the difference data of a plurality of image data;

and a step of performing the pixel value adjustment process based on the second image data acquired by way of an imaging process causing the first light source to emit light when a proportion of the whole image of the moving portion is higher than a predetermined threshold value; wherein

the pixel value adjustment data based on the second image data is set as a final pixel value adjustment data.

13. The captured image data processing method according to claim 12, characterized in that the pixel value adjustment process based on the second image data is either a white balance adjustment process according to a parameter set based on a light component of the first light source, the white balance adjustment process according to a parameter set based on ambient light component not containing the first light source, or a white balance adjustment process according to a parameter set based on an intermediate light component between the first light source and ambient light component not containing the light component of the first light source.

14. A captured image data processing apparatus characterized by:

a memory for storing first image data acquired by way of an imaging process causing the first light source not to emit light, and a second image data acquired by way of an imaging process causing the first light source to emit light; and

a data processing unit for performing a pixel value adjustment process based on the image data stored in the memory; the data processing unit including:

a difference image data acquisition unit for subtracting, from a pixel value of each pixel which constitutes the second image data, a pixel value of a corresponding pixel of the first image data, so as to acquire difference image data corresponding to image captured in an irradiation environment of only the first light source;

a difference image data pixel value adjustment unit for performing the pixel value adjustment process with respect to the difference image data; and

a final pixel value adjustment unit for performing a final pixel value adjustment by using an image data of adjusted pixel values generated in the difference image data pixel value adjustment unit.

15. The captured image data processing apparatus according to claim 14, characterized in that the data processing unit further includes first image data pixel value adjustment unit for performing pixel value adjustment process with respect to the first image data; wherein

the final pixel value adjustment unit is arranged to perform pixel value addition process for corresponding pixels of two image data of adjusted pixel values generated in the difference image data pixel value adjustment unit and the first image data pixel value adjustment unit, and generate the final pixel value adjustment image data.

16. The captured image data processing apparatus according to claim 15, characterized in that the pixel value adjustment process is a white balance adjustment process;

the difference image data pixel value adjustment unit is arranged to perform the white balance adjustment process according to a parameter set based on a light component of the first light source; and

the first image data pixel value adjustment unit is arranged to perform the white balance adjustment process according to a parameter set based on ambient light component not including the first light source.

17. The captured image data processing apparatus according to claim 14, characterized in that the data processing unit further includes a pixel value adding unit for adding a pixel value of each pixel of the image data of adjusted pixel values generated in the difference image data pixel value adjustment unit to a pixel value of a corresponding pixel of the first image data, and the final pixel value adjustment image generating unit performs pixel value adjustment with respect to image data generated in the pixel value adding unit, and generate the final pixel value adjustment image data.

18. The captured image data processing apparatus according to claim 17, characterized in that the pixel value adjustment process is a white balance adjustment process; and

the difference image data pixel value adjustment unit performs white balance adjustment process according to a parameter set based on ambient light component not including the first light source.

19. The captured image data processing apparatus according to claim 14, characterized in that the data processing unit includes :

a motion detection unit for detecting a moving portion of a subject based on difference data between a plurality of image data; and

a moving portion pixel value adjustment unit for performing pixel value adjustment process with respect to the moving portion.

20. The captured image data processing apparatus according to claim 19, wherein the moving portion pixel value adjustment unit is characterized by:

calculating a light intensity scalar ratio of two light sources when the first light source is caused or not caused to emit light, as data corresponding to a pixel of a motionless portion adjacent to a moving portion;

calculating light intensity scalar ratio corresponding to each pixel of the moving portion by applying a radial basis function (RBF);

calculating pixel value as first pixel value of each pixel of the moving portion in an image which is equivalent to the captured image in an irradiation environment of only the first light source, based on light intensity scalar ratio corresponding to each pixel of the moving portion;

calculating pixel value as second pixel value of each pixel of the moving portion in an image which is equivalent to the captured image in an ambient light irradiation environment where the first light source is not included, based on light intensity scalar ratio corresponding to each pixel of the moving portion;

performing pixel value adjustment process, based on the first pixel value;

performing pixel value adjustment process based on the second pixel value; and

adding the generated two adjustment pixel values to perform a moving portion pixel value adjustment process.

21. The captured image data processing apparatus according to claim 20, characterized in that the pixel value adjustment process is a white balance adjustment process;

the first pixel value adjustment process is performed as the white balance adjustment process according to a parameter set based on a light component of the first light source; and

the second pixel value adjustment process is performed as a white balance adjustment process according to a parameter set based on ambient light component not including the first light source.

22. The captured image data processing apparatus according to claim 19, wherein the moving portion pixel value adjustment unit is characterized by:

calculating a color component ratio (α_r, α_g, α_b) of the pixel value of an inner peripheral pixel of the moving portion to an average value of the pixel value of an outer peripheral pixel of the moving portion adjacent to the inner peripheral pixel of the moving portion;

constructing a radial basis function (RBF) based on the color component ratio corresponding to each pixel by considering all the inner peripheral pixels in the moving portion as sample points;

calculating the color component ratio corresponding to each pixel of the moving portion based on the radial basis function (RBF); and

multiplying the color component ratio with an image to be compensated, and obtaining a compensation pixel value.

23. The captured image data processing apparatus according to claim 19, wherein the data processing unit is characterized by:

performing the pixel value adjustment process based on the second image data acquired by way of an imaging process causing the first light source to emit light when a proportion of the whole image of the moving portion detected by the motion detection unit is higher than a predetermined threshold value, and the pixel value adjustment data based on the second image data is set as final pixel value adjustment data.

24. The captured image data processing apparatus according to claim 23, characterized in that the pixel value adjustment process based on the second image data performs either a white balance adjustment process according to the parameter set up based on the light component of the first light source, the white balance adjustment process according to the parameter set up based on ambient light component not including the first light source, or the white balance adjustment process according to the parameter set up based on an intermediate light component between the light component of the first light source and ambient light component not including the first light source.

25. A captured image data processing method characterized by:

a step of acquiring first image data by way of an imaging process causing the first light source not to emit light;

a step of acquiring a second image data by way of an imaging process causing the first light source to emit light;

a step of subtracting, from a pixel value of each pixel which constitutes the second image data, a pixel value of a corresponding pixel of the first image data, and acquiring a difference image data corresponding to the image captured in an irradiation environment of only the first light source;

a difference image data pixel value adjustment processing step of performing the pixel value adjustment process with respect to the difference image data; and

a final pixel value adjustment image generation step of generating a final pixel value adjustment image by using the adjusted pixel value image data generated in the difference image data pixel value adjustment processing step.

26. A captured image data processing method characterized by:

a step of acquiring a plurality of image data captured at mutually different times in a situation where light-emitting conditions of a first light source are the same;

a step of acquiring motion information based on comparison among the plurality of image data; and

a step of performing a process according to white balance set based on the motion information, with respect to either the plurality of image data, a portion thereof, all of them, or other image data.

27. The captured image data processing method according to claim 26, characterized in that, in the step of performing the process according to the white balance set based on the motion information, the white balance is adjusted with respect to a portion corresponding to other image data captured either during a period when the plurality of image data is captured, or immediately before or immediately after the plurality of image data is captured,.

28. The captured image data processing method according to claim 26, characterized in that, when it is determined that a motion is large based on the motion information, the white balance adjustment process is carried out based on either ambient light, flash light, or a virtual light source between ambient light and the flash light, in the step of performing the process according to the white balance set up based on the motion information.

29. The captured image data processing method according to claim 26, characterized in that the step of performing the white balance treatment process set based on the motion information further includes a step of adaptively switching the white balance adjustment processes for each portion of the image, instead of an uniform process for the entire image, and, based on the motion information, the image is interpolated

from the image data of a still portion adjacent to a corresponding portion so as to obtain image data of the corresponding portion.

30. A captured image data processing apparatus characterized by:

an imaging means for acquiring a plurality of image data by way of an imaging process causing a first light source not to emit light and an imaging process causing the first light source to emit light;

a memory for storing first image data acquired by way of the imaging process causing the first light source not to emit light and a second image data acquired by way of the imaging process causing the first light source to emit light; and

a data processing unit for performing a pixel value adjustment process based on the image data stored in the memory; wherein

the data processing unit includes:

a difference image data acquisition unit for subtracting, from a pixel value of each pixel which constitutes the second image data, a pixel value of a corresponding pixel of the first image data, so as to acquire a difference image data corresponding to the image captured in an irradiation environment of only the first light source;

a difference image data pixel value adjustment unit for performing a pixel value adjustment process with respect to the difference image data; and

a final pixel value adjustment unit for performing a final pixel value adjustment by using an image data of adjusted pixel values generated in the difference image data pixel value adjustment unit.

31. A captured image data processing apparatus characterized by:

means for acquiring a plurality of image data captured at mutually different times in a situation where light-emitting and imaging conditions of a first light source are the same;

means for acquiring motion information based on a comparison

between the plurality of image data; and

means for performing a process according to a white balance set based on the motion information, with respect to either the plurality of image data, a part thereof, all of them, or other image data.

32. A computer-readable program for making a computer execute steps of image data processing, the computer program characterized by:

a step of acquiring first image data by way of an imaging process causing a first light source not to emit light;

a step of acquiring a second image data by way of an imaging process causing the first light source to emit light;

a step of subtracting, from a pixel value of each pixel which constitutes the second image data, a pixel value of a corresponding pixel of the first image data, and acquire a difference image data corresponding to the image captured in an irradiation environment of only the first light source;

a difference image data pixel value adjustment processing step of performing a pixel value adjustment process with respect to the difference image data; and

a final pixel value adjustment image generation step of generating a final pixel value adjustment image by using the adjusted pixel value image data generated in the difference image data pixel value adjustment processing step.

33. An image data processing method for performing a pixel value compensation process with respect to image data having a saturation pixel value, the method characterized by:

a temporary compensation pixel value calculation step of inputting a plurality of image data including first image data to be compensated having saturation pixels in which at least a part of pixels of the image data are set up as a maximum pixel value, and one or more

sub-image data captured under an exposure condition different from that for the first image data; acquiring an exposure condition difference data, based on mutually corresponding pixel value differences in a plurality of input image data, which indicates a difference in the exposure condition at a time of acquiring each image data; and calculating a temporary compensation pixel value of the saturation pixel in the first image data, based on the exposure condition difference data; and

a compensation pixel value calculation step of performing a normalization process for correcting the temporary compensation pixel value to a pixel value within an outputable range.

34. The image data processing method according to claim 33, characterized in that:

the first image data has pixel values (Rc1, Gc1, Bc1) in saturation pixel position (Xc, Yc), and has pixel values (Ru1, Gu1, Bu1) in non-saturated pixel (Xu, Yu); the sub-image data includes a second image data as a captured image of a lower intensity exposure than the first image data and a third image data as a captured image of an exposure of still lower intensity than the second image data;

the temporary compensation pixel value calculation step performs a calculation process according to the following equations, assuming that the pixel value in the position corresponding to the non-saturated pixel (Xu, Yu) of the first image data in the second image data and the third image data are (Ru2, Gu2, Bu2) and (Ru3, Gu3, Bu3),

$$P(Xu,Yu)=\sqrt{\left(\frac{(Ru1-Ru3)}{(Ru2-Ru3)}\right)^2+\left(\frac{(Gu1-Gu3)}{(Gu2-Gu3)}\right)^2+\left(\frac{(Bu1-Bu3)}{(Bu2-Bu3)}\right)^2}$$

.... (equation 1)

$$S = \frac{\sum P(Xu, Yu)}{n}$$

.... (equation 2)

and calculates an exposure condition difference data :S based on the above (equation 1) and (equation 2).

35. The image data processing method according to claim 33, characterized in that:

the compensation pixel value calculation step performs a calculation process according to the following equations, assuming that the pixel values of the position corresponding to the saturation pixel (Xc, Yc) of the first image data in the second image data and the third image data are (Rc2, Gc2, Bc2) and (Rc3, Gc3, Bc3),

Rcq = (Rc2 - Rc3) x S + Rc3

Gcq = (Gc2 - Gc3) x S + Gc3

Bcq = (Bc2 - Bc3) x S + Bc3

.... (equation 3)

and, based on (equation 3), calculates the temporary compensation pixel values (Rcq, Gcq, Bcq) of the saturation pixel of the first image data.

36. The image data processing method according to claim 33, characterized in that:

the compensation pixel value calculation step calculates a maximum value: Dmax of all data of pixel values (Ru, Gu, Bu) of the non-saturated pixel (Xu, Yu) of the first image, and the temporary compensation pixel values (Rcq, Gcq, Bcq) with respect to the saturation pixel (Xc, Yc), performing the calculation process according to the following equations,

where the non-saturated pixel (Xu, Yu),
Ruf = Ru/Dmax
Guf = Gu/Dmax
Buf = Bu/Dmax

where the saturation pixel (Xc, Yc),
Rcf = Rcq/Dmax
Gcf = Gcq/Dmax
Bcf = Bcq/Dmax
.... (equations 4)

and, based on (equations 4), calculates the compensation pixel values (Ruf, Guf, Buf) of the non-saturated pixel of the first image data and the compensation pixel values (Rcf, Gcf, Bcf) of the saturation pixel.

37. The image data processing method according to claim 33, characterized in that the difference in exposure conditions between the first image data and one or more sub-image data is a difference in irradiation light intensity; and the temporary compensation pixel value calculation step calculates a ratio of amount of irradiation light based on the difference in the irradiation light intensity of a plurality of image data as the exposure condition difference data.

38. The image data processing method according to claim 33, characterized in that the difference in the exposure conditions between the first image data and one or more sub-image data is the difference in exposure time, and the temporary compensation pixel value calculation step calculates the ratio of irradiation light intensity based on the difference in the exposure time of a plurality of image data as the exposure condition difference data.

39. The image data processing method according to claim 33, characterized in that the temporary compensation pixel value calculation step and the compensation pixel value calculation step are characterized by calculating a compensation data on each signal component of a color image in the first image.

40. The image data processing method according to claim 33, characterized in that the temporary compensation pixel value calculation step and the compensation pixel value calculation step calculate the compensation data according to a luminance component of the first image.

41. An imaging method for capturing image data to be stored in a memory unit, the method characterized by:

an imaging step of capturing image upon setting up different exposure conditions;

a temporary compensation pixel value calculation step of inputting a plurality of image data including first image data to be compensated and having a saturation pixel which at least part of pixels in the image data is set up as a maximum pixel value, and one or more sub-image data captured under an exposure condition different from that for the first image data; acquiring an exposure condition difference data, based on mutually corresponding pixel value differences in a plurality of input image data, which indicates a difference in the exposure condition at a time of acquiring each image data, and calculating a temporary compensation pixel value of the saturation pixel in the first image data, based on the exposure condition difference data;

a compensation pixel value calculation step of performing a normalization process of correcting the temporary compensation pixel value to a pixel value within an outputable range; and

a store step of storing the image data constituted by the pixel

value compensated by the compensation pixel value calculation step.

42. The imaging method according to claim 41, characterized in that the difference between the exposure conditions is either a difference in irradiation light intensity, or a difference in exposure time, the imaging step captures a plurality of image data under the different setup conditions of the irradiation light intensity or the exposure time, and the temporary compensation pixel value calculation step calculates the ratio of irradiation light intensity based on the difference in the irradiation light intensity or the exposure time of the plurality of image data as the exposure condition difference data.

43. A captured image data processing apparatus for performing a pixel value compensation process with respect to image data having a saturation pixel value, the image data processing apparatus characterized by:

a temporary compensation pixel value calculation means for inputting a plurality of image data including first image data to be compensated and having saturation pixels in which at least a part of pixels of the image data are set up as a maximum pixel value, and one or more sub-image data captured under an exposure condition different from that for the first image data; acquiring an exposure condition difference data, based on mutually corresponding pixel value differences in a plurality of input image data, which indicates a difference in the exposure condition at a time of acquiring each image data, and calculating a temporary compensation pixel value of the saturation pixel in the first image data, based on the exposure condition difference data; and

compensation pixel value calculation means for performing a normalization process for correcting the temporary compensation pixel value to a pixel value within an outputable range.

44. A computer program for executing an image data process including a pixel value compensation process with respect to an image data which has a saturation pixel value, the computer program characterized by:

a temporary compensation pixel value calculation step of inputting a plurality of image data including first image data to be compensated and having a saturation pixels in which at least part of pixels in the image data are set up as a maximum pixel value, and one or more sub-image data captured under an exposure condition different from that for the first image data; acquiring an exposure condition difference data, based on corresponding pixel value differences in a plurality of input image data, which indicates a difference in the exposure condition at a time of acquiring each image data, and calculating a temporary compensation pixel value of the saturation pixel in the first image data, based on the exposure condition difference data; and

a compensation pixel value calculation step of performing a normalization process for correcting the temporary compensation pixel value to a pixel value within an outputable range.